SSNP123 - Plate notched in elastoplasticity: test of elements QUAD4 under integrated

Summarized:

This quasi-static test in plane strains makes it possible elastoplastic constitutive law to illustrate the relative questions with the incompressibility during the use of one: when the rate of plasticity becomes important, of the nonphysical oscillations of stresses can appear. It is shown that the use of elements QUAD4 and HEXA8 under integrated can make it possible to mitigate this problem.

It is about a notched rectangular plate made up of an elastoplastic material with isotropic hardening which is subjected to a tension at its ends. One is interested in the elastoplastic solution in load.

The modelization A to the use of elements QUAD4 under integrated stabilized by the method “assumed strain corresponds”.

The modelization B corresponds to the use of the incompressible elements QUAD8 which make it possible to The modelization obtain a reference solution for modelization A.

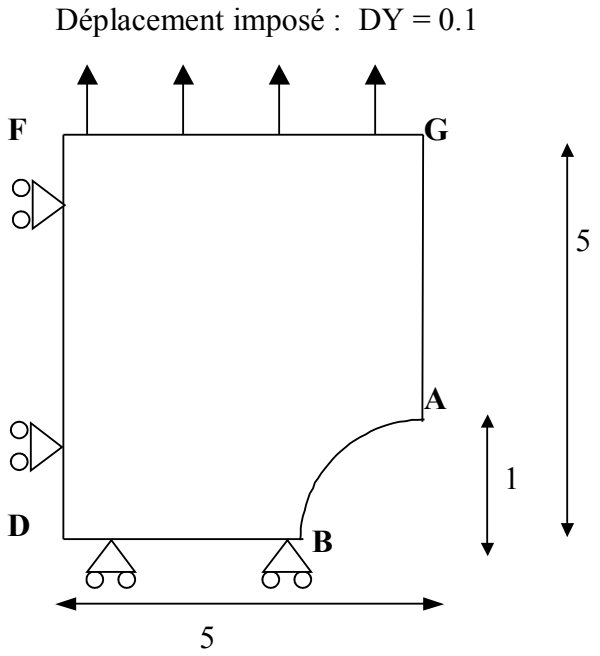
C corresponds to the use of elements HEXA8 under integrated stabilized by the method “assumed strain”.

The modelization D corresponds to the use of the incompressible elements HEXA20 which make it possible to C obtain a reference solution for the modelization.

1 Problem of reference

1.1 Geometry

This computation leans on the modelization of a notched sample requested by an imposed displacement.

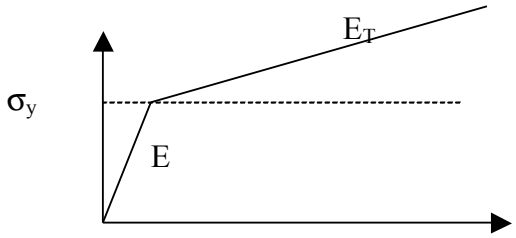


1.2 Material properties

Behavior elastoplastic with isotropic hardening:

$E = 200\,GPa$
$\nu = 0.4999$

$\sigma_y = 200\,MPa$
$E_T = 1000\,MPa$



1.3 Boundary conditions and loadings

On BD : $DY = 0.$
On DF : $DX = 0.$
On FG : $DY = 0.1$

2 Reference solution

the reference solution of the modelization A (respectively modelization C) is given by the modelization B (respectively modelization D) carried out with incompressible elements quasi -.

3 Modelization A

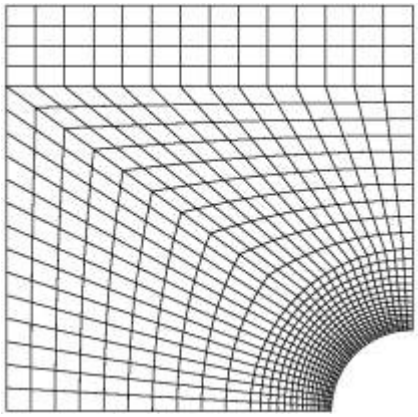
3.1 Characteristic of the modelization

Modelization C_PLAN with elements QUAD4 under integrated stabilized by the method assumed strain.

3.2 Characteristics of the mesh

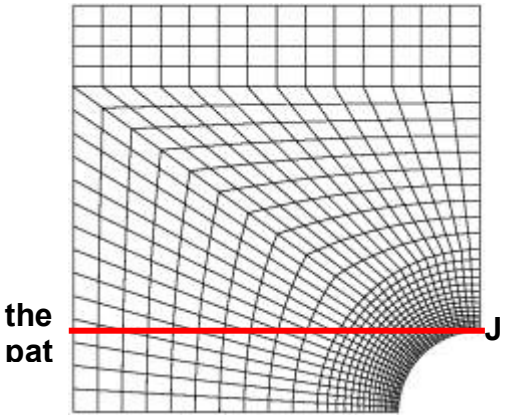
Many nodes: 527

Number of meshes: 582
SEG2: 102
QUAD4: 480



3.3 Quantities tested and results

One I tests $SIYY$ the coordinate of the tensor of the stresses in various points of IJ



Curvilinear abscisse	Reference
0.0	234.174
1.54051	257.417
3.26795	300.333
3.83403	263.212
4.37942	175.829

One carries out also a test of non regression on the values above.

4 Modelization B

4.1 Characteristic of the modelization

One takes again the preceding mesh which one passes in quadratic elements with an aim of using modelization D_PLAN_INCO (elements adapted to the incompressible problems).

4.2 Characteristics of the mesh

Many nodes: 1533

Number of meshes: 582
SEG3: 102
QUAD8: 480

4.3 Quantities tested and results

One tests the coordinate $SIYY$ of the tensor of the stresses in various points of the path IJ into non regression.

Curvilinear abscisse	Reference
0.0	234.174
1.54051	257.417
3.26795	300.333
3.83403	263.212
4.37942	175.829

5 Modelization C

5.1 Characteristic of the modelization

One 3D_SI uses a modelization with elements HEXA8 under integrated stabilized by the method assumed strain. The mesh used is an extrusion of the mesh of the modelization A on a height of $0,1\,m$ with only one element in the thickness. All the degrees of freedom are blocked according to Z in order to approaching the assumption of the plane strains used in the modelizations A and B.

5.2 Characteristic of the mesh

Many nodes: 1054

Number of meshes: 1731
QUAD4: 1052
HEXA8: 480

5.3 Quantities tested and results

One compared to the tests $SIYY$ the coordinate of the tensor of the stresses in various points of IJ the path modelization D.

Abscisse Curviligne	Reference
0.0	234.122
1.53224	256.988
3.26890	300.287
3.80797	267.555
4.40378	183.498

6 Modelization D

6.1 Characteristic of the modelization

One takes again the preceding mesh which one passes in quadratic elements with an aim of using modelization 3D_INCO (elements adapted to the incompressible problems).

6.2 Characteristics of the mesh

Many nodes: 1054

Number of meshes: 1731
SEG3: 199
QUAD8: 1052
HEXA20: 480

6.3 Quantities tested and results

One tests the coordinate $SIYY$ of the tensor of the stresses in various points of the path IJ into non regression.

Curvilinear abscisse	Reference
0.0	234.12162679
1.53224	256.98783319
3.26890	300.28717384
3.80797	267.55482696
4.40378	183.49849877

7 Summary of the results

the results got using the various elements under integrated stabilized by the method “assumed strain” are very close to the results provided by the incompressible quadratic elements, as one can note it on the graph below. This graph gathers the results for various elements:

HEXA8	classical elements HEXA8
QUAD4	elements QUAD4 classics
HEXA20	quadratic elements HEXA20
HEXS20	quadratic elements HEXA20 incompressible
HEXS8	elements HEXA8 under integrated
QUAD8	quadratic elements QUAD8
QUAS8	quadratic elements QUAD8 incompressible
QUAS4	elements QUAD4 under integrated

One thus notes the good quality of the solution given by the elements under integrated and the disappearance of the oscillations of stresses given by the linear classical elements.